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Monthly Progress Report
Heat Source Technology Programs
March 1994

Compiled by
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MONTHLY PROGRESS REPORT
HEAT SOURCE TECHNOLOGY PROGRAMS
MARCH 1994

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MONTHLY PROGRESS REPORT

HEAT SOURCE TECHNOLOGY PROGRAMS

MARCH 1994

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T. G. George

ABSTRACT

This monthly report describes activities performed in support of Cassini fueled-clad production and studies related to the use of $^{238}\text{PuO}_2$ in radioisotope power systems carried out for the Office of Special Applications of the U.S. Department of Energy (DOE) by Los Alamos National Laboratory (LANL). Most of the activities described are ongoing; the results and conclusions described may change as the work progresses.

I. HEAT SOURCE AND FEED POWDER SHIPMENTS

The first delivery of fuel for Cassini flight-quality applications, designated as shipment 469, was received from the Westinghouse Savannah River Company (WSRC) mid-December. Although thirteen of the fourteen fuel containers received in this shipment were released to the Heat Source Technology Group (NMT-9) in mid-January, resolution of a shipper/receiver difference for the fourteenth container (SN-1434) prevented its release until 23 March.

The second delivery of fuel for Cassini flight-quality applications, designated as shipment 470, was received from WSRC at the beginning of February. Calorimetry measurements for the six containers received in this shipment were completed in early March, and the containers were released to NMT-9.

The third delivery of fuel for Cassini flight-quality applications, designated as shipment 473, was received from WSRC at the end of the month.

II. IRIDIUM HARDWARE SHIPMENTS AND INVENTORY

On 17 March, a Quality Assurance representative from Martin Marietta Energy Systems' Y-12 (MMES/Y-12) plant observed the unpacking, inspection, and storage of iridium

components received in shipment 10411. The LANL inventory of GPHS hardware, as of 31 March, is shown in Table I.

Table I. LANL Inventory of GPHS Iridium Hardware

Type of Hardware	Category	Number of Items in Inventory
PICS*	Prime	233
PICS	Restricted Use	52
Type II Weld Shields	Prime	297

*PICS = post-impact containment shell

III. FACILITIES

A. General

During March, authorization to operate equipment and gloveboxes required to support Cassini production continued to be delayed by the slow response of organizations responsible for work approval, scheduling, and performance, and by conflicting priorities established for the facility Safety and Technical Assessment for Readiness of Technology (START) Review Committee.

A third radiological control technician (RCT) was permanently assigned to the NMT-9's $^{238}\text{PuO}_2$ operations at TA-55. However, actual RCT coverage throughout the month ranged from zero to three technicians. During periods of reduced RCT coverage only limited activities were permitted within the $^{238}\text{PuO}_2$ operations area; these periodic curtailments had a significant effect on the progress of Cassini production activities.

B. Launcher Relocation

Work continued in March on construction of an addition to PF-4 to house the relocated launcher and on a number of related procurements.

1. Construction Activities

Painting of the interior of the launcher addition was complete by 15 March. However, a small section of interior wall was left unpainted; finish work on this section was postponed until after final installation of the launcher.

Painting of structural steel elements that will be used in the launcher addition was also complete by the end of the month. Installation of some elements was initiated.

A work order for removal of vacuum pumps from a section of the PF-4 basement, where the exhaust filter train of the addition's HVAC system will be located, was approved and placed in the JCI work schedule.

Electrical work required to complete installation of the bridge crane was finished by mid-March. Inspection and load testing of the crane were performed on 23 March. The bridge crane was approved for use and will be used for subsequent installation work.

2. Design Activities

At the end of February, JCI authorized fabrication of a filter train for the launcher addition's heating, ventilation, and air conditioning (HVAC) system. A meeting was held in mid-March between representatives from the Laboratory's Nuclear Materials Technology (NMT) and Engineering (ENG) Divisions, and JCI, to develop a plan to address deficiencies in the filter train design. At the close of the meeting it appeared that all of the deficiencies could be corrected at moderate additional cost and a short delay.

Revised shop drawings for the pressure doors were approved by the architectural and engineering (A&E) contractor. The approved drawings and control specifications were forwarded to the door vendor. The expected shipping date for the pressure doors was 25 March.

3. Procurements

Specifications for duct expansion sections of the launcher addition's HVAC system were completed and transmitted to JCI for procurement or fabrication.

Dampers for the launcher addition's HVAC system were received at the beginning of the month.

4. Administrative Activities

Work on safe operating procedures (SOPs) for the launcher facility continued throughout the month. In mid-March, personnel from the NMT training group agreed that the process SOPs should be organized into an operations manual. A senior technical writer was then assigned to define the manual content, format, training requirements, etc.

C. Metallography and Ceramography Glovebox Lines

All of the gloveboxes in the metallography and ceramography lines have been installed and wired for electric power. A bench-top metallographic facility for "cold" (uncontaminated) specimens was activated previously and has been used to support fueled-clad weld-process development.

On 9 November, NMT-9 requested a facility-required Safety and Technical Assessment for Readiness of Technology (START) review of the glovebox line and metallography operation. A review committee was selected, and convened on 23 November. Twenty five committee findings and a number of additional comments were provided to NMT-9 on 15 December. No operations may be conducted in the glovebox line until after all of the "A" findings identified by the START committee have been closed, and approved action plans are in place to address the "B" findings.

Work to address all of the findings and comments received from the START review committee was completed by mid-March. However, the ongoing TA-55 DOE Order Compliance Self-Assessment (OCSA) delayed closeout of the review and authorization for startup through the end of the month.

IV. GENERAL-PURPOSE HEAT SOURCE (GPHS) PROGRAM

A. Preproduction Activities

1. GPHS Fuel Powder, Pellet, and Fueled-Clad Specifications

A revised version of the GPHS $^{238}\text{PuO}_2$ Feed Powder Specification (LANL Drawing No. 26Y-318180) was approved for use on 15 March.

2. Fueled-Clad Weld Development

During November, four plutonia pellets were encapsulated within clad/vent-sets. The welds on all four capsules appeared to be exemplary, and each capsule easily passed through the ring gauge. Metallographic examination of the capsule welds was postponed, pending the startup of the hot metallography line.

3. Fueled-Clad Ultrasonic Test (UT) Development

On 1 February, a meeting of the GPHS welding/UT working group was held in Atlanta, Georgia. Eleven action items were assigned at the meeting; six of the eleven action items were assigned to LANL. Work to close four of the action items assigned to LANL had been completed by the end of March.

4. Cold Process Verification (CPV) Tests

The CPV test series was designed to verify that the welding process for simulant-fueled ("cold") capsules had been optimized and to quantify the impact responses of the hot-pressed, and cold-pressed and sintered, urania fuel-simulants.

Most of the simulant-fueled clads required for the CPV test series were welded previously. Eight capsules were loaded with hot-pressed urania (^{235}U -depleted) fuel-simulant and seven capsules were loaded with cold-pressed urania. UT examination performed with the existing Panametrics system indicated that the welds in nearly three-quarters of the capsules (11 of 15) contained indications that exceeded the proposed UT acceptance criterion.

The postmortem examinations of capsules tested in CPV-1 and CPV-2 were completed previously. The status of ongoing postmortem examinations is given in the following sections.

a. CPV-3. On 26 February 1993, capsule SC0004, which had been loaded with cold-pressed and sintered urania fuel-simulant, was impacted against a steel plate at 55.0 ± 0.1 m/s and 1090 °C. The iridium hardware used for this capsule was designated as "Prime" and was from the D2 batch. Postimpact examination revealed that although the capsule contained two small transverse cracks on the cup radii at the edges of the impact face, no urania had been released. Details of this initial examination, as well as the metallographic examination of selected clad sections and a preliminary sieve analysis, were documented in previous monthly reports.

In this month we made no progress on the CPV-3 postmortem examination.

b. CPV-4. On 5 March, 1993, capsule SC0020, which had been loaded with cold-pressed and sintered urania fuel-simulant, was impacted against a steel plate at 55.3 ± 0.2 m/s and 1090 °C. The iridium hardware used for this capsule was X- and YR-batch

material (vent cup ID, X342-2; shield cup ID, YR421-1) produced for the Galileo and Ulysses missions. Postimpact examination revealed that capsule SC0020 had been breached by several cracks and that a small amount of urania had been released into the tantalum containment vessel. Details of this initial examination were documented in previous monthly reports.

In this month we continued with the metallographic examination of sections removed from capsule SC0020, and with a sieve analysis of the retained and released urania fuel-simulant.

c. CPV-5. On 15 June, capsule SC0017, which had been loaded with cold-pressed and sintered urania, was impacted against a steel plate at 55.3 ± 0.1 m/s and 1090°C. The iridium hardware for this capsule was designated as "Prime" and was from the D2 batch. Postimpact examination revealed that capsule SC0017 had breached, and that a small quantity of urania had been released. Details of this initial examination were documented in previous monthly reports.

In this month we made no progress on the CPV-5 postmortem examination.

d. CPV-6. On 29 June, capsule SC0018, which had been loaded with cold-pressed and sintered urania, was impacted against a steel plate at 55.0 ± 1.0 m/s and 1090 °C. The iridium hardware used for this capsule was designated as "Prime" and was from the CR3 batch. Postimpact examination of the impacted capsule revealed that although a network of hairline axial cracks was visible on the impact face, no urania had been released. Details of this initial examination were documented in previous monthly reports.

In this month we made no progress on the CPV-6 postmortem examination.

e. CPV-7. On 13 July, capsule SC0019, which had been loaded with cold-pressed and sintered urania, was impacted against a steel plate at 55.3 ± 0.1 m/s and 1090 °C. The iridium hardware used for this capsule was X- and YR-batch material (vent cup ID, X340-4; shield cup ID, YR427-6) produced for the Galileo and Ulysses missions. Postimpact examination revealed that the capsule exhibited a centerline weld failure on the trailing face; however, no urania was released into the tantalum containment vessel. Details of this initial examination were documented in previous monthly reports.

In this month we made no progress on the CPV-7 postmortem examination.

f. CPV-8. On 17 November, capsule SC0006, which had been loaded with a cold-pressed and sintered urania pellet, was impacted against a steel plate at 55.3 ± 0.1 m/s and 1090 °C. The iridium hardware used for this capsule was designated as "Prime" and was from the CR3 batch.

In this month we made no progress on the CPV-8 postmortem examination.

g. CPV-9. On 24 November, capsule SC0015, which had been loaded with a hot-pressed and sintered urania pellet, was impacted against a steel plate at 54.5 ± 0.1 m/s and 1090 °C. The iridium hardware used for this capsule was designated as "Prime" and was from the CR3 batch.

In this month we made no progress on the CPV-9 postmortem examination.

h. CPV-10. On 10 December, capsule SC0009, which had been loaded with a hot-pressed and sintered urania pellet, was impacted against a steel plate at 55.5 ± 0.2 m/s and

1090 °C. The iridium hardware used for this capsule was designated as "Prime" and was from the CR3 batch.

In this month we made no progress on the CPV-10 postmortem examination.

i. CPV-11. On 19 January, capsule SC0016, which had been loaded with a hot-pressed and sintered urania pellet, was impacted against a steel plate at 54.8 ± 0.1 m/s and 1090 °C. The iridium hardware used for this capsule was X- and XR-batch material (vent cup ID, X312-2; shield cup ID, XR367-2) produced for the Galileo and Ulysses missions.

In this month we made no progress on the CPV-11 postmortem examination.

B. Cassini Fueled-Clad Production

Processing of flight fuel received in shipments 469 and 470 continued throughout March. Although shipment 470 was not released to NMT-9 until mid-month, all of the fuel received in shipments 469 and 470 had been processed through granule seasoning or into GPHS pellets by 31 March. A total of seven GPHS pellets were pressed.

By 31 March, impurity analyses became available for some samples of as-received and processed fuel from shipment 469. These preliminary results indicated that the fuel received in shipment 469 was significantly cleaner than previous WSRC shipments. The results also suggested that the levels of some impurities, such as aluminum and silicon, may have increased during processing at Los Alamos. However, the small number of analyses performed on processed fuel, and uncertainties associated with the analytical technique did not firmly establish this observation as a definite trend.

C. Safety Test Program

In early March a mechanical engineer from LANL's Engineering Science and Applications (ESA) Division was contracted to act as chief engineer for safety tests performed in support of the Cassini mission. This engineer worked throughout the month to obtain information on the dimensions and availability of concrete blocks at Kennedy Space Center.

Two NMT-9 staff members attended a Cassini Safety Test program meeting at Fairchild Space in Germantown, Maryland on 24 March.

D. Research and Development

In response to a request from the program office, and to resolve questions concerning the behavior of fuel with a high silicon content, we previously identified a high vacuum furnace that could be temporarily modified to duplicate EG&G Mound Applied Technologies' module reduction and monitoring facility (MRMF).

In March, a differentially pumped residual gas analyzer (RGA) was hooked up to the vacuum furnace that will be used as an MRMF. A variable leak valve was installed in the system to admit gas to the RGA while maintaining a constant pressure. In the event that other analyses are required, the system was also fitted with a sample port so that gas bottles can be filled and then analyzed later, or by other laboratories.

Test runs of the substitute MRMF revealed that the major contaminant in the system was water vapor. However, water vapor contamination is easily reduced by multiple cycles of evacuation and backfilling with inert gas.

A stainless steel enclosure for positioning GPHS modules within the substitute MRMF was received in early March. The enclosure was lined with graphite felt to protect and insulate the GPHS module, and was vacuum outgassed. By 23 March, the substitute MRMF was complete and ready for use.

E. Project Management

All required weekly status reports were delivered on schedule. The program Project Management System (PMS) monthly status report (which included a data disk) was also delivered to FSC (the operator of the program PMS) on schedule.

V. LIGHT-WEIGHT RADIOISOTOPE HEATER UNIT (LWRHU) PROGRAM

A. LWRHU Weld Development

On 8-10 March, a WSRC weld engineer visited LANL and continued with the weld development program. Several welds were made using stainless steel hardware machined to the same dimensions as the LWRHU capsule. Metallographic evaluation of the test welds continued until 22 March, when the WSRC engineer returned to LANL and performed development welds on six empty LWRHU capsules.

B. LWRHU Production

The fifth hot-press run for LWRHU pellets was completed in the first week of March. A die assembly that had been shortened by 0.5 mm was used for this run, and the end load was increased to the same value used for pressing GPHS pellets. The load was applied throughout the pressing cycle and was maintained until the die had cooled below 700 °C. The as-pressed pellets from this run had lengths that ranged from 9.82 to 9.97 mm.

Because the extended load time appeared to yield pellets that were closer to the desired length, in the sixth hot press run the load was maintained on the hot press die until approximately two hours after the termination of induction heating. In addition, instead of using a virgin powder charge, the overlength pellets produced in the second hot press run were used for this experiment. After this second pressing, the pellets had lengths that ranged from 9.64 to 9.81 mm; all of the pellets were expected to meet dimensional specifications after sintering.

A class II NCR was written for the pellets fabricated in the first five hot press runs; the recommended second hot pressing was expected to bring these pellets into specification. After approval had been received, all of the pellets were given a second hot pressing with the extended time under load. The as-pressed pellet lengths ranged from 9.53 to 9.86 mm.

By the end of the month, all of the fuel required to meet the Cassini requirement had been processed through granule seasoning and 80 LWRHU pellets had been pressed and sintered.

C. Primary Shipping Containers

All 30 of the LWRHU primary shipping containers were vacuum outgassed.

D. Administrative Requirements

Procedure RHU-NMT9-PP-9 "Weighing and Dimensioning of LWRHU Fueled Clads " was written and submitted for DOE/NE-53 approval.

E. Safety Test Program

Two aeroshell subassemblies were sent to the graphite shop for machining of a hole in the lid and the end of each assembly so that the lids could be locked in place during vibration testing. The machining operations were complete by 15 March.

VI. 60-WATT HEAT SOURCE PROGRAM

A. Preproduction Activities

In this month, installation of the hot isostatic press (HIP) continued to be delayed by other facility priorities. Although installation work was suspended between 12 January and 21 February, work resumed on 22 February and continued sporadically throughout March. By 31 March, the installation was approximately 60% complete and was expected to be finished by 11 April.

When the HIP unit has been connected to all building services, a factory representative will be scheduled to start up the unit and install a gas reclaim feature. After the unit has been demonstrated as operational, a facility START review will be requested. The START review must be closed out before any programmatic activities can be performed. In the interim, arrangements have been made with another LANL group for HIPing simulant-fueled clads.

B. Technical Support

Simulant-fueled capsule SC0024 (cold-pressed urania pellet no. 22; CVS no. 2301) was shipped to LANL's Materials Science and Technology (MST) Division for HIPing during the second week of March, and was returned on 21 March. The results of dimensional and leak-rate measurements performed on the HIPed capsule are presented in Table II.

Table II. Pre- and Post-HIP Measurements Obtained from Capsule SC0024

Condition	Diameter (mm)		Length (mm)	Weight (g)	Leak Rate (cm ³ ...atm/s)
	Parallel ^a	Perpendicular ^b			
Pre-HIP	29.929	29.765	30.093	197.328	1.9 X 10 ⁻¹⁰
Post-HIP	29.474	29.534	29.305	197.329	2.2 X 10 ⁻¹⁰

^a Diameter was measured parallel to alignment marks on the capsule.

^b Diameter was measured perpendicular to alignment marks on the capsule.

VII. 1-kW SHIPPING CONTAINER

A. Container Opening Facility

A LANL facility for receipt and opening of 1-kW shipping containers became operational in February.

B. Container Welding Facility

Design work on a design for a system to load the 1-kW shipping container onto an automated weld fixture continued throughout the month. On 23 March, a WSRC weld engineer assisted NMT-9 personnel in modifying the design of the 1-kW welding fixture to permit installation in an existing glovebox. A target date for startup of the 1-kW welding facility was established as 15 July, 1994.

VIII. PROGRAMMATIC MEETINGS AND VISITORS

Members of a mentor team selected by DOE/HQ were present on site throughout the month.

Several personnel from the Office of Nuclear Safety were on site during the first week of March and performed several observations in the $^{238}\text{PuO}_2$ processing area.

Two NMT-9 staff members attended a Defense Nuclear Facilities Safety Board (DNFSB) hearing in Washington, D.C. on 7 March.

Two NMT-9 staff members attended a 60-watt monthly program meeting in Hunt Valley, Maryland on 8 March.

One NMT-9 staff member attended a DNFSB hearing in Washington, D.C. on 15 March.

Three NMT-9 staff members attended the Cassini quarterly program review held at EG&G MAT on 15 March.

Several personnel from the Office of Nuclear Safety were on site during the third week of March to assess NMT-9 and facility compliance with the "TA-55 Deliberate Operations Plan."

On 8-10 March, a WSRC weld engineer visited LANL to continue with LWRHU weld development.

On 17 March, a Quality Assurance representative from Martin Marietta Energy Systems' Y-12 (MMES/Y-12) plant observed the unpacking, inspection, and storage of iridium components received in shipment 10411.

On 22 March, the WSRC weld engineer who visited previously returned to LANL and performed development welds on six empty LWRHU capsules.

Two NMT-9 staff members attended a Cassini Safety Test program meeting at Fairchild Space in Germantown, Maryland on 24 March.

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